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AGRICULTURAL MEMORANDUM NO 979

Foot-and-mouth disease: Denmark and German Democratic Republic - 1982

by

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SOURCES OF INFORMATION

DISEASE DATA

1. Reports received from the Office International Des Epizooties (O.I.E.).
2. Dr Eskildsen, State Veterinary Institute for Virus Research, Lindholm, Denmark.
3. Visitors to the Animal Virus Research Institute (A.V.R.I.), Pirbright, England.

METEOROLOGICAL DATA

1. 3 hourly surface charts of North Western Europe.
2. Upper atmospheric data from soundings taken at Copenhagen Airport (Kastrup), Denmark.
3. Sea temperature data from the Danish Meteorological Institute, Nautical Department.

FH2B

DISEASE SUMMARY

Between March and May 1982 there were two series of outbreaks of Foot-and-Mouth Disease (FMD); one in Denmark and the other in the German Democratic Republic (GDR). Both series lasted from the middle of March until early May. The sequences of events in both countries are given in Tables 1 and 2 and the approximate locations of the affected farms in Figure 1. Disease data and control measures for both of the countries are described separately below.

DENMARK

There were 22 confirmed cases of disease in Denmark of which 21 were located on the Island of Funen and 1 on the neighbouring Island of Zealand. On Funen the outbreaks were divided into three groups; one in the south-east, a second towards the centre of the island and the third in the extreme north. Once disease had been confirmed sanitary measures were brought into operation and all the affected herds were destroyed and buried. Appendix 1 describes the sanitary measures in detail.

During the outbreak 4200 animals were destroyed - 1800 cattle and 2400 pigs. Disease was largely confined to cattle. Tests at the State Veterinary Institute for Virus Research, Denmark identified the virus as type O_1.

GDR

21 cases of FMD were reported to O.I.E. by the GDR Veterinary Service. The first case was declared in the Neubrandenburg district, near the town of Anklam and spread then occurred towards the north and north-west. Animals on infected premises were slaughtered and strict veterinary measures applied (see Appendix 1). Tests made at the Wladimir International Laboratory for Foot-and-Mouth Disease identified the virus as type O_1.

In 16 of the 21 outbreaks 13,263 cattle, 1430 pigs and 1267 sheep were destroyed; for 5 other outbreaks no figures were given. Disease was chiefly confined to cattle, most of which were young stock; but there were three outbreaks in pigs.

ANALYSIS OF OUTBREAKS

The almost simultaneous occurrence, the similarity of virus types, and the proximity of the outbreaks in GDR and Denmark is not inconsistent with a common disease origin.

From Table 1 there would have been insufficient time for disease to have spread from GDR to Denmark or vice versa; a period of at least 4 days is required to allow for virus transmission, infection, development of clinical signs and recognition of disease. For Denmark or GDR to have been the original source of infection disease would have to have been present prior to the first reported case.

It is possible that an unknown virus source outside of GDR or Denmark was responsible for both series of outbreaks. If infection occurred by airborne transmission of virus, in both countries simultaneously, it is likely that the virus source would have been either to the north-west of the outbreaks in Denmark or to the south-east of those in GDR; so that the initial virus source a and primary outbreaks in Denmark and GDR lie roughly along a straight line.

The following meteorological analysis examines the possibility of airborne virus providing the required vector for disease transmission.

PERIOD OF ANALYSIS

From previous studies the incubation period of cattle, sheep, pigs and goats has been found to be 4 to 14 days following transmission between farms (Sellers and Forman , 1973 and Hugh-Jones and Tinline, 1976). Consequently virus emitted into the atmosphere during the first part of March could have been responsible for subsequent infection.

FAVOURABLE CONDITIONS FOR LONG DISTANCE DISEASE SPREAD OVER THE SEA

Gloster and others (1982) concluded that the following criteria needed to be satisfied simultaneously if disease spread over a long sea passage was likely to occur:-

(1) Large numbers of susceptible livestock exposed to virus for many hours.

(2) High virus survival.

(3) Low virus dispersion.

(4) High virus output.

(1) LARGE NUMBERS OF SUSCEPTIBLE LIVESTOCK EXPOSED TO VIRUS FOR MANY HOURS.

Table 3 gives the general wind direction over the Baltic Sea during the first 14 days of March. The period began with a dominance of westerly winds which were associated with two mobile low pressure systems. By the 6th high pressure built up over the region and this lasted until 9th when it was replaced by further mobile low pressure systems. During the period of high pressure the wind direction was apparently suitable for carriage of any airborne virus from the south-east to Denmark.

Figure 2 gives a breakdown of the surface air movements for 7th and 8th March. It can be seen that air from the south-east passed over or close to the Island of Funen for approximately 24 hours. However, an analysis based on surface wind direction alone provides only a "first look" at the likely track of airborne particles. A more rigorous analysis, which includes amongst others the effect of variation of wind direction with height, is required to determine the precise track of any such particles. This analysis is in the process of being performed.

(2) HIGH VIRUS SURVIVAL.

Virus survival in the atmosphere is related to the relative humidity (RH) of the air. If the RH stays above 60% the virus survives for many hours but below this level it soon becomes inactivated (Barlow, 1972, Donaldson, 1972). During the 7th and 8th March the RH of the air at the surface and for at least 400 m above this, was above 60%. The RH must have been close to 100% for part of the period, as patches of sea fog were observed.

(3) LOW VIRUS DISPERSION

Dispersion in the atmosphere can be estimated using meteorological measurements. The period 7 to 8 March has been divided into two parts and the atmospheric dispersion estimated.

ATMOSPHERIC DISPERSION DURING THE NIGHT OF 7/8 MARCH

At mid-day on 7 March surface air temperatures in Northern GDR were close to 4°C. Over night on 7/8 March the sky was clear and the windspeed light (≤ 5 knots) and as a result the surface air temperature fell to -1°C. Away from the surface the temperature increased with height and at 1000 m was +2.2°C. These atmospheric conditions were ideal for very low dispersion (slow mixing and dilution) of atmospheric particles over the land; it has been estimated that the maximum height for dispersion of particles emitted at the ground was in the order of 150 m. As the air passed over the sea vertical dispersion of particles would have increased. With the mean sea temperatures of 1.5°C particles would have been able to diffuse up to 400 m*. Maximum vertical dispersion would have been limited to this height for the remainder of its passage to Denmark.

ATMOSPHERIC DISPERSION DURING THE DAY (8 MARCH)

During the day the presence of large scale sinking air, which warmed as it descended (anticyclonic conditions) limited the potential for rapid atmospheric dispersion. Despite temperatures over the land of 6°C and over the sea of +3°C vertical virus dispersion would have been limited to about 400 m from the surface.

In summary atmospheric dispersion of particles would have been limited throughout the whole period when the airstream was common to Denmark and GDR outbreak areas and further to the south east.

CONCLUSION

The meteorological conditions, which existed during part of the infection period for cattle in Denmark, were ideal for long distance disease spread from GDR or from further to the south-east. Whilst there is no information of a virus

Footnote: * The vertical extent of dispersion of particles in the atmosphere is normally substantially greater than 400 m.

source, around 7/8 March, the geographical location and meteorological conditions strongly support a hypothesis of airborne disease transmission.

ACKNOWLEDGEMENTS

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Any comments or suggestions on this paper should be referred to the author, Meteorological Office, London Road, Bracknell, Berkshire.

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N Disease notified

TABLE 1 SEQUENCE OF EVENTS IN DENMARK (D) AND EAST GERMANY (E)

MARCH

Outbreak Number		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	D								N														
	E									N													
2	D													N									
	E									N													
3	D													N									
	E														N								
4	D													N									
	E														N								
5	D														N								
	E														N								
6	D														N								
	E														N								
7	D														N								
	E																	N					
8	D															N							
	E																			N			
9	D															N							
	E																			N			
10	D																						N
	E																				N		
11	D																						N
	E																				N		
12	D																					N	
	E																						
13	D																						N
	E																						

JB

TABLE 2 SEQUENCE OF EVENTS IN DENMARK (D) AND EAST GERMANY (E) CONTINUED

APRIL

Outbreak Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
10	D																						
	E																						
11	D																						
	E																						
12	D				N																		
	E																						
13	D					N																	
	E																						
14	D						N																
	E		N																				
15	D							N															
	E		N																				
16	D								N														
	E			N																			
17	D														N								
	E				N																		
18	D																N						
	E									N													
19	D																					N	
	E										N												
20	D																					N	
	E											N											
21	D																					N	
	E																						

4 May Danish Outbreak Number 22
East German Outbreak Number 21

TABLE 3 WIND DIRECTION OVER THE BALTIC SEA

MARCH

1	2	3	4	5	6	7	8	9	10	11	12	13	14
SW	SW → W	S → SW	SW	NW	NW → W → C → SE	SE → E	SE	SE	S → SE	S → SW → NW	SW → S	W → SW	SW

E - Easterly

SE - South Easterly

S - Southerly

SW - South Westerly

NW - North Westerly

C - Confused

SE→E - Between Southeasterly and Easterly

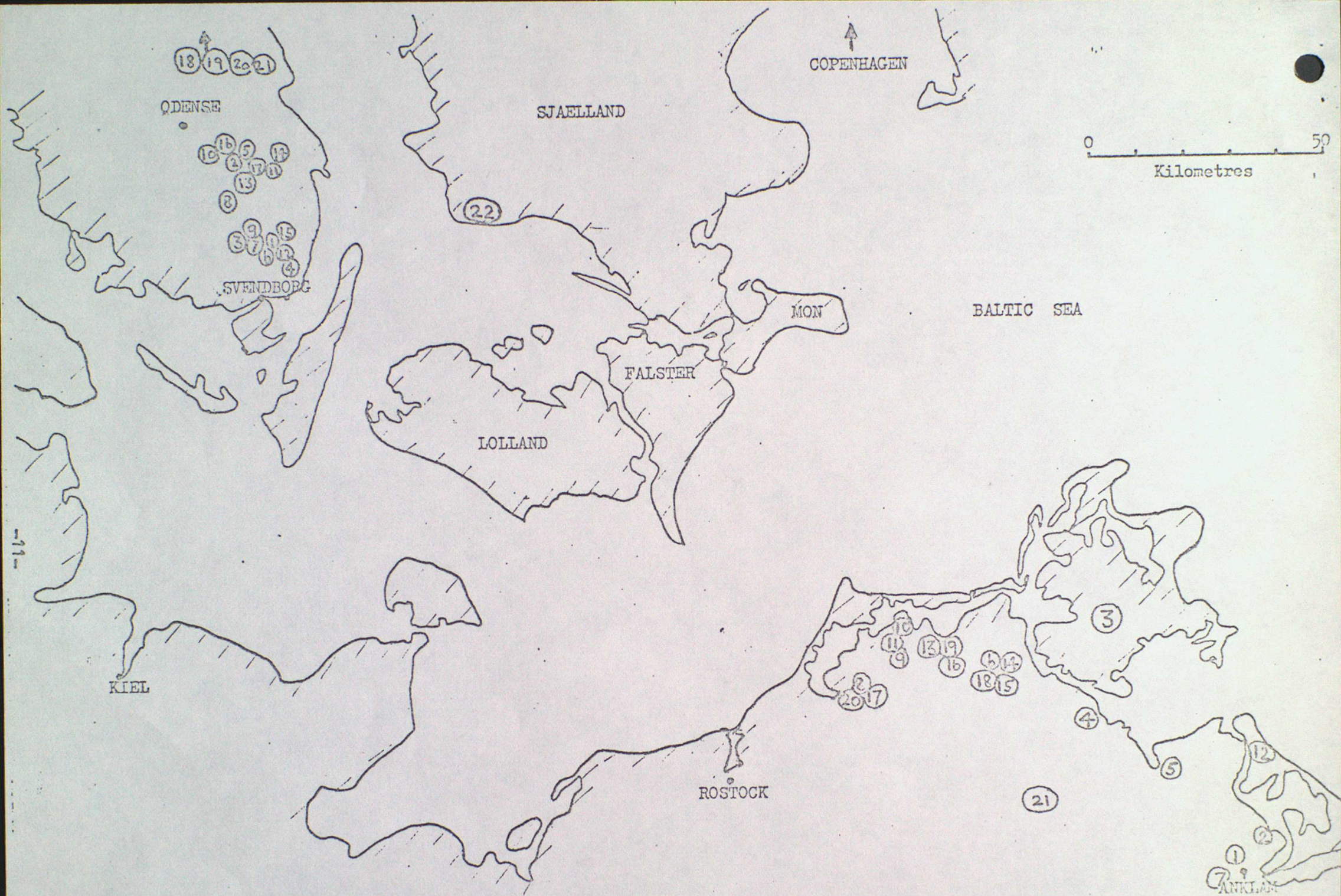

FIGURE 1 LOCATION OF REPORTED DISEASE OUTBREAKS IN DENMARK AND EAST GERMANY

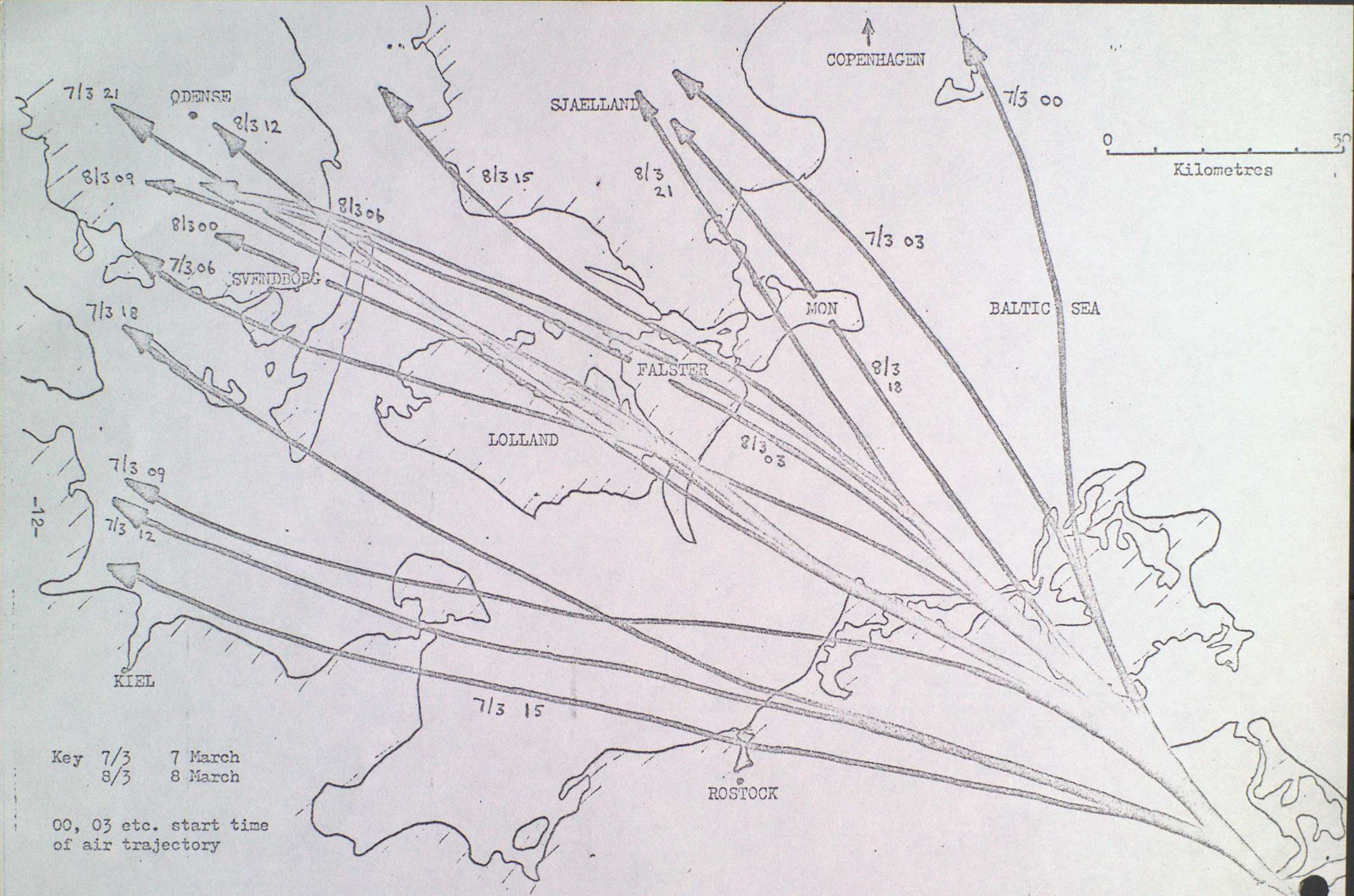

FIGURE 2 AIR TRAJECTORY ANALYSIS FOR 7 AND 8 MARCH 1982

APPENDIX I

The following extracts taken from telexts issued by the Office International Des Epizooties, describe the sanitary measures implemented in Denmark and the German Democratic Republic.

DENMARK

"(1) The establishment of a cordon sanitaire

The radius of the cordon sanitaire is about 250 m. All susceptible animals within the area are killed and destroyed. It is prohibited to remove non-susceptible animals. Animal products, animal feed, waste and utensils from the cordon sanitaire, the movement of persons to and from the area is subject to authorisation by the police.

(2) The establishment of a control area

The control area has a radius of at least 10 km from any of the herds destroyed due to Foot-and-Mouth Disease. The following measures apply to the area:

- the movement of cloven-hoofed animals from one farm to another is prohibited,
- it is prohibited for any visitor, including cattle and pig dealers, production recording technicians etc. to enter farms with cloven-hoofed animals,
- it is prohibited from a farm to remove animal feed (hay, straw etc.) and manure,
- it is prohibited for milk and truckdrivers to enter barns.

Only veterinarians are permitted to visit farms with cloven-hoofed animals.

Slaughtering of animals can only take place in local slaughter-house (without export license). A movement permit is necessary.

There are no export licensed slaughter-houses within the control area.

(3) The County of Funen (Island of Funen)

It is prohibited to remove from the Island of Funen cloven-hoofed animals, animal feed, manure and animal offall.

Markets, fair, shows and sales are prohibited.

Transit of cloven-hoofed animals via the Island of Funen is prohibited.

Milk produced on the Island of Funen can only be brought to milk plants located at the Island. They and milk used for animal feed must have undergone a heat treatment of 80 centigrades (pass the Storch's test). Milk and cream used for milk products for human consumption must have undergone a heat treatment of 72 centigrades for 15 sec. (pass the phosphatase test).

Drivers of milktruck cannot enter barns with cloven-hoofed animals.

A.I. is prohibited on pigs and cattle in the country of Funen.

(4) Denmark

Farmers have been advised to inspect their herds 3-4 times daily for any sign of Foot-and-Mouth Disease and upon any sign to report to a veterinary surgeon.

If called by a farmer to visit a herd which may show signs of Foot-and-Mouth Disease, the practising veterinarian shall immediately call the state veterinary service and if possible the requested visit will be carried out by a full-time salaried state veterinary officer.

Practising veterinarians shall when leaving a farm with cloven-hoofed animals use a 5% citric acid or a 0.2% NaOH solution as a disinfectant."

GERMAN DEMOCRATIC REPUBLIC

"The communes in which the affected farms are located have been completely cut off from the rest of the region.

The districts in which the communes are located have been reported protected areas in which all transport of animals is prohibited.

Visits and tourist traffic in these districts have been subjected to strict controls.

All animals in protected areas have been re-vaccinated against FMD*. Meanwhile the virus has been established as type O1 and has been sent to the Wladimir International Laboratory for Foot-and-Mouth Disease in Moscow."

Footnote: * Cattle are vaccinated in the German Democratic Republic as routine.